Improvised (Varanasi) Video Laryngoscope (IVL)

Peer-reviewed scientific reports indicate the superiority of video laryngoscopy over direct laryngoscopy for endotracheal intubation. Presently, commercially available video laryngoscopes are very expensive, and blade designs are not standardized, unlike the McIntosh blade used in direct laryngoscopy. There is no open-source video laryngoscope design that can be built with relatively low-cost components available to civilian consumers using low-to-moderate crafting skills.

The Improvised Varanasi Video Laryngoscope (IVL) is built using an IPX6 standard water-proof multi USB HD snake camera (endoscope camera / borescope camera) of 5.5 mm outer diameter, focal distance 20 to 80 mm, with inbuilt LED light, rigidly mounted on standard reusable Macintosh blades no. 4 and blade no. 3. The handle was that of a standard light bulb laryngoscope. All the materials and tools used in this project are commercially available on leading online shopping platforms, with a total cost of . The final configuration was mechanically tested with 60 consecutive manikin laryngoscopy and intubation over 4 hours. No rotational, axial, or torsional displacement was observed. The camera did not obstruct bougie or ETT passage along the convex curvature of the tongue/spatula of the laryngoscope blade.

Materials and tools list with approximate cost on online shopping platforms (as on Feb 2026)

IVL hand unit:

1. Macintosh laryngoscope with adult size 3 & 4 reusable blades, with carrying case. Rs. 2000/-
2. HD Endoscope camera / Borescope camera / Snake camera (5.5 mm outer diameter, 1920p, USB-C, and USB-A). INR 1200/-
3. Needle file set. INR 450/-
4. Screwdriver kit (5 piece set). INR 200/-
5. Isopropyl alcohol 300 mL. INR 250/-
6. Non woven kitchen towel roll. INR 230/-
7. Fevikwik advanced 3 g tube (water proof, shock proof, fast setting cyanoacrylate adhesive). INR 75/-
8. Loctite Multipurpose Epoxy 25 mL (clear and colorless, water and chemical resistant, non shrinking, two part epoxy adhesive sealant). INR 250/-
9. Acetone 400 mL bottle (for adhesive spills cleanup). INR 250/-
10. Baby Shampoo (for application on the camera lens as antifogging agent). INR 400/-
11. Cotton ear buds pack (for lens cleaning, antifogging agent application and buffing). INR 100/-

Total cost of IVL hand unit: INR 5,500/- (USD 60/-)

Display Unit Option - Mobile Phone

1. Android mobile phone with at least 6.5 inch screen, HD display (with 600 - 120 Hz Refresh Rate), 4GB RAM, and USB-C. INR 8000/-. [If the user owns an Android or I-phone with a USB-C-type connection, and can use the phone in air-plane mode with OTG connection with the endoscope camera for live video during the use of IVL, this cost is nil]
2. Phone mount with pole clamp. INR 300/-
3. IV pole stand. INR 1400/-
4. OTG View app (for mobile display): Android, I-phone, Free of cost.

Cost: INR 1,700/- to 9,700/- (USD 19/- to 107/-)

Display Unit Option - Laptop PC / Desktop PC / Tablet PC

1. Certified Refurbished Laptop PC with 8 GB RAM, SSD, 14” HD DisplayWindows 10 / 11. INR 11,000/- [If the user owns a laptop or desktop PC or tablet PC with USB-A / USB-C connection, and can use the same with the endoscope camera for live video during the use of IVL, this cost is nil]
2. Height Adjustable Multi Purpose Trolley Table with Castors. INR 2000/-
3. The IVL can be connected to a laptop PC or desktop PC running Windows 10 or above with the Windows Camera app. OTG View app for Android, I-Pad tablets. Free of cost.

Cost: INR 2,000/- to 13,000/- (USD 22/- to 143/-)

1. Laryngoscope Blade Preparation

Standard reusable Macintosh blades no. 4 and no. 3 were taken. The bulb was removed from the bulb holder. Then the bulb holder and internal wiring were removed from the blade by inserting the sharp end of a screwdriver into the bulb housing and prying slowly and firmly. Using a flat file and needle file, all jagged metal edges, epoxy and welding residues, sharp projections were removed. A cotton swab test confirmed the absence of snag points.

2. Surface Preparation

Both the medial surface of the blade web (vertical step), and the metallic camera head surface were thoroughly degreased using isopropyl alcohol 99.9% sprayed onto a non-woven lint-free kitchen towel roll (using for degreasing and dedusting). Surfaces were not touched after degreasing.

3. Camera Positioning Through the Web Slot

The camera head was passed through the empty longitudinal slot in the blade web (previous bulb-holder location), from left to right, lens oriented to the right, camera cable exiting to the left, (orientation defined as per standard laryngoscopy position.)

The camera was connected to the USB port of a Windows 10 PC, and the Windows Camera application was started. Using the live video display, the camera was positioned and dialed precisely so that the blade tip was visible in the upper ~10% of the screen; and the junction of web and tongue/spatula was visible at the upper left. This ensured preserved anatomical orientation and spatial referencing.

4. Two-Point Cyanoacrylate Pre-Fixation

Two small counterbalancing drops of fast setting cyanoacrylate adhesive, with shock proof and water proof bonding (Fevikwik Advanced, Pidilite Industries Ltd., Mumbai, India) were applied. One drop between distal medial camera surface and blade web; another drop between proximal medial camera surface and blade web. Purpose: temporary rapid stabilization by opposing contact points. This step prevented any drift during epoxy placement.

5. Primary Structural Bond (Epoxy Fillet)

Loctite Multipurpose Epoxy (Henkel Corporation, USA), a high-strength, water, heat and chemical resistant, transparent epoxy adhesive was applied as a thin controlled fillet within the interface gap between the blade web and the camera shaft. Excess adhesive outside the bonding plane was strictly avoided. The assembly was allowed to cure undisturbed at room temperature for 24 hours.

6. Conformal Reinforcement Wrap

After full cure of the epoxy bond, except for the distal 2 mm of the camera tip, the camera and blade assembly were draped in a conformal wrap using transparent waterproof polyurethane medical film 5 cm width roll (Jusore, China), cut into 2 cm strips.

This was applied under moderate stretch, as three layers of circumferential wraps. finished on the underside of the blade, taking care not to leave any air pockets or crevices.

Purpose: Distributed compression, Edge protection, Anti-peel reinforcement, Smooth surface contour, Hypoallergenic Medical Barrier Film between the camera head fitted with cyanoacrylate and epoxy adhesives and the user.

This wrap is reinforcement only and not the primary fixation.

Mechanical Testing and Outcome

Testing: 60 consecutive laryngoscopy attempts by qualified anesthesiologists on manikin over 4 hours.

Observed, No rotational movement, No axial shift, No epoxy fracture, No obstruction to bougie/ETT advancement along the tongue/spatula, Stable field of view throughout

This configuration of the mounting of the camera on the laryngoscope bladed used Web-slot geometric constraint, Two-point Cyano Acrylate Adhesive preload fixation, High-strength epoxy bond (shock, shear, vibration, heat, water and chemical proof), Distributed polyurethane conformal compression, Near total coverage of the camera and chemical adhesives bond by a medical grade polyurethane transparent film dressing.

Cleaning and disinfection of blade with camera assembly

1. Cleaning (Decontamination): Rinse the blade under cool running tap water to remove debris. Clean with enzymatic cleaner or detergent and a soft brush to remove all soil. Rinse again with lukewarm water and dry with a lint-free cloth.
2. Disinfection (after cleaning and drying):
    a. ETO Sterilization is preferred
    b. High-Level Disinfection (HLD): Soak in 2% glutaraldehyde or ortho-phthalaldehyde (OPA) for 20 minutes; or soak in Rely+On™ PeraSafe 16.2g/L concentration for 10 minutes; or soak in Virkon® S 2% solution for 10 minutes.

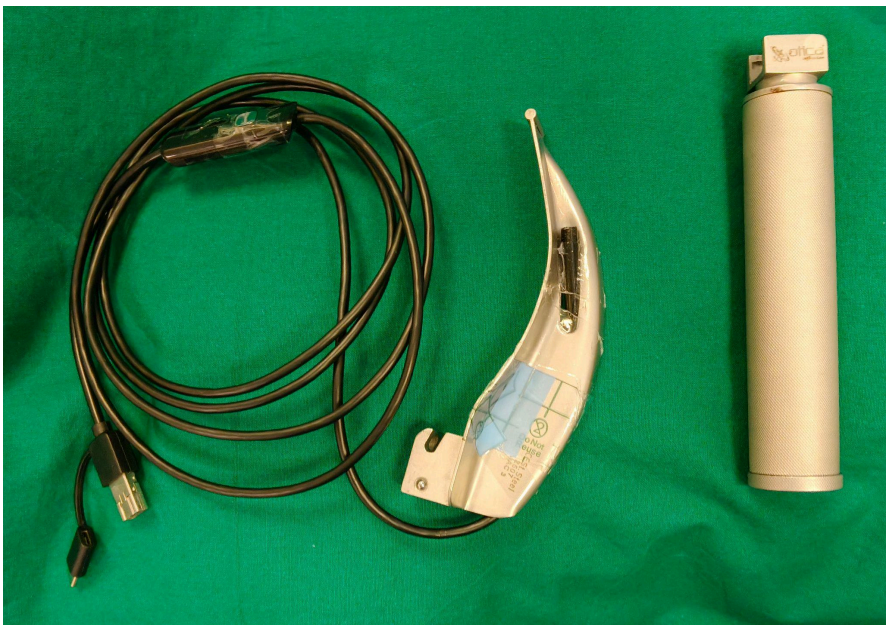

Figure 1a

Figure 1b

Figure 1c

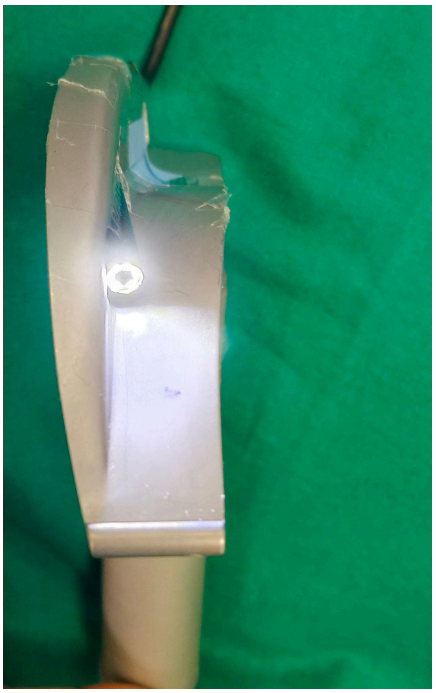

Figure 1d

Figure 1e

Figure 1a - 1e: Improvised (Varanasi) Video Laryngoscope - components and view of standard profiles after 60 consecutive laryngoscopy attempts on manikin over 4 hours.

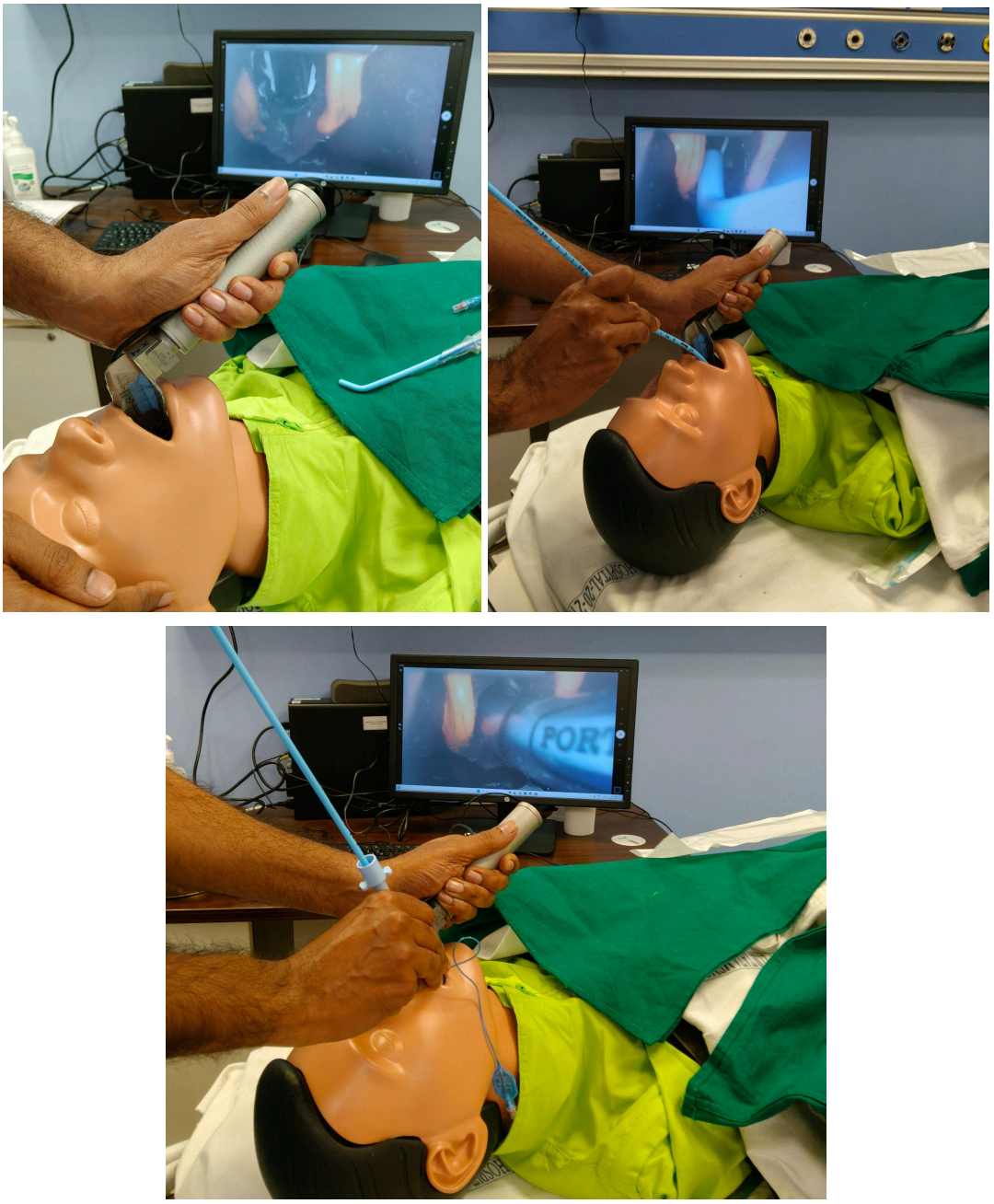

Figure 2: Intubation in an airway manikin by Improvised (Varanasi) Video Laryngoscope

Intellectual Property and Licensing Statement

The improvised (Varanasi) videolaryngoscope (IVL) design, fabrication methodology, descriptive documentation, and prototype images have been developed by Prof. Jyotirmay Kirtania in his individual capacity, outside the scope of official institutional duties, and without institutional or commercial funding.

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The improvised videolaryngoscope described in this work is a simulation-only educational prototype and is not a regulator-approved medical device for use in patients.

Prof. Jyotirmay Kirtania's affiliation with MPMMCC and HBCH (Tata Memorial Centre) Varanasi under the Department of Atomic Energy, Government of India, does not imply institutional ownership or governmental endorsement of the device.

The improvised (Varanasi) videolaryngoscope (IVL) fabrication manual, descriptive documentation, and prototype images are released under the Creative Commons Attribution–ShareAlike 4.0 International License (CC BY-SA 4.0).

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